LALP-99-244

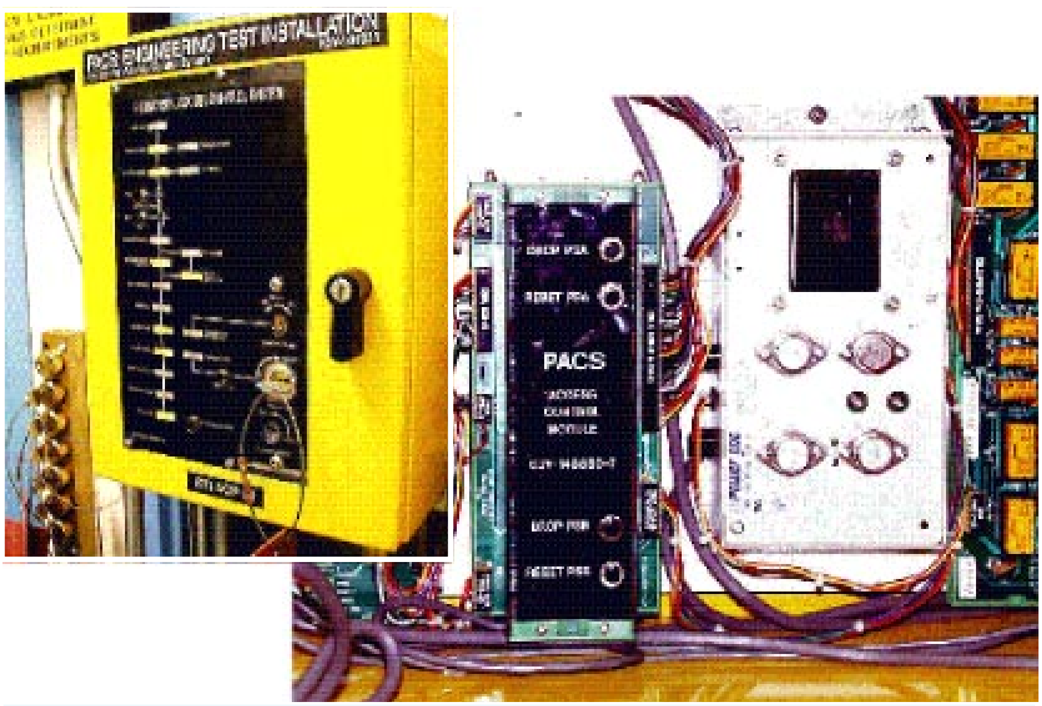
LANSCE DIVISION TECHNOLOGY REVIEW

Radiological Hazards

The Personnel Access Control System (PACS) and its extension, the Experimental Area Personnel Access Control System (EPACS), prevent exposure to prompt radiation at the Los Alamos Neutron Science Center (LANSCE) by controlling access to areas in twenty locations along the primary beam line (PACS) and in the experimental areas (EPACS) where access to secondary beam lines is a concern. These two unique systems, which input to the Radiation Security System (RSS)—the umbrella radiation safety system at LANSCE—are upgrades that will replace existing personnel safety systems. They comprise various innovative electronic assemblies and Kirk-key access-control hardware that are designed to achieve compliance with regulatory requirements (DOE Order 420.2 and LANL LIR 402-701-01.2), which standardize and improve the reliability and quality of access-control systems at accelerator facilities.

The Personnel Access Control System (PACS) upgrades and replaces the original personnel safety system currently used to control primary beam-line access to prompt radiation and high-voltage hazards. The Experimental Area Personnel Access Control System (EPACS) upgrades and will replace the instrument-personnel-access control system currently used to control secondary beam-line access to prompt radiation. Being components of the Radiation Security System (RSS)—the umbrella radiation safety system at the Los Alamos Neutron Science Center (LANSCE)—subjects them to the same requirements as engineered safety systems.

PACS/EPACS provides redundant contacts indicating its protective state. These are processed by the RSS to provide the required protective functions. A typical PACS system has barrier sensors that inform the system if a barrier has been opened, SCRAM switches that will stop beam delivery if pushed, sweep reset switches that verify that an area sweep has been performed, and sirens and strobe lights to warn personnel in the area of impending beam operations. A personnel interface near the area being controlled allows workers to determine whether it is safe to gain access to the affected area so that sweeps can be performed before the area is secured. The main electronics enclosure houses the relay logic that controls PACS, a programmable logic controller (PLC) that performs non-critical timing functions and communications, power supplies, and a maintenance panel that displays system conditions and faults (Fig. 1). The Kirk-key release node contains a battery backup system that



▲ Fig. 1. The PACS interface panel, Kirk-key system, and yellow electronics enclosure are shown (left). An inside view of the enclosure shows the access control module and power source (right).

ensures that the system will be able to monitor secured areas during a short power outage, and a PLC that monitors the beam stopper configuration to ensure that an area is safe before a key release is issued. The accelerator operator interface in the Central Control Room (CCR) in conjunction with the key release node allows keys to be issued for access when the area is safe.

A typical EPACS system also has barrier sensors (modified from the PACS design to include connectors that allow the areas to be easily reconfigured), personnel interface near the area being controlled, and a battery backup and Kirk-key release node (Fig. 2). EPACS, however, automatically allows access to the controlled area when beam stoppers are inserted into the secondary beam line. EPACS has one main electronics enclosure that houses three printed circuit boards (PCB). These PCBs are assembled with ribbon cable to allow quick field replacement. The EPACS also houses a Kirk-key release mechanism and is designed with relay logic, but the system does not have a PLC as does PACS. The reset, SCRAM, and sirens were combined into one enclosure to simplify the layout, and several new sensors were designed to accommodate fence-barrier loops.

A typical personnel sweep is controlled by a written procedure. When the sweep start button is pushed on the operator interface panel, the sirens automatically sound for 30 seconds. After the siren has sounded, the sweep team enters the area, proceeds to the first sweep station, and pushes the reset button. The team then carefully inspects the area between the first and second sweep station to be certain that no personnel are present and then pushes the reset switch on the second sweep station to verify that the area has been secured. After pushing the second reset button, the team sweeps the area between the second and third station and pushes the third reset switch to again verify that the area has been secured. This procedure continues until a sweep of the entire affected area has been completed. A timer allows the team to exit the area after the last reset switch has been pushed (Fig. 2). When the keys are returned (or the sweep is verified), the sirens are again sounded, and after a 30-second delay, the affected area is secured.

We have completed the development and installation of PACS in twenty locations along the primary beam line at LANSCE for the existing facility. The proton radiography experimental facility, which is located in an existing primary beam-line area, was upgraded to PACS last year. Provisions have been made to extend PACS to new beam lines like the Isotope Production Facility (IPF), which is being installed at the north port in the linac transition region. A separate PACS and RSS were installed at the facility that houses the Low-Energy Demonstration Accelerator, and EPACS will be installed on the four new SPSS flight paths being constructed at the Lujan Center. The system will be extended to the rest of the flight paths at the Lujan Center and to the flight paths at WNR as funding permits.

EPACS was developed by modifying PACS to account for the needs of secondary beam lines in the experimental areas in the Lujan Center, WNR, and Area A when service resumes. EPACS became a natural extension of PACS into these same areas. The primary difference between the two systems is how

▲ Fig. 1. Jim Sturrock, LANSCE-6 team leader of the Protective Systems Team, pushes the reset button after completing a practice sweep of an area while demonstrating how PACS operates.

▲ Fig. 3. The EPACS user-interface panel has been designed like the PACS panel so that people who access these areas will see, and become familiar with, the same interface in all areas.

beam-line access is allowed. In primary beam lines, access is controlled by the configuration of the accelerator beam stoppers and requires permission from accelerator operators. In a secondary beam line, access is controlled by the beam stoppers for that particular experiment and access is allowed automatically if the area is safe (i.e., if the beam stoppers are inserted).

PACS wiring is run in dedicated conduit or cable trays because of the permanent nature of the primary beam lines. EPACS is soft wired (not in conduit) and connected by plugs to the various components that make up the EPACS system so that changes can be made to the experiment with minimal time and effort. For example, the old personnel safety system in 4FP30R at WNR is being removed to reconfigure the area with EPACS. It will take electricians several days to remove the old conduit, and if the old personnel safety system were to be reinstalled instead of EPACS, it would take them a couple of weeks to put the system back in place. The soft-wiring configuration of EPACS will allow electricians to remove the system in four hours and replace it in two days. The soft wiring and plug connections are protected by extensive interlock and fault-detection circuitry. The following general design considerations were incorporated into EPACS:

- an EPACS user-interface panel (Fig. 3) similar to PACS;
- self-checking circuitry and fail-safe design of sensor loop wiring to allow the use of soft wiring and add confidence to the integrity of the system;
- loud warning devices to warn people of impending beam-allowed conditions;
- self-directing control panels, indicating flow and status of the personnel sweep, located both at the access point and at the main enclosure to assist sweep personnel;

- battery backed-up Kirk-key release mechanism with provisions for a mechanical, key-controlled override for emergency access under any condition, and a key-driven restricted-access capability to allow managers to control access to an area;
- minimal power, battery backed-up indication of access control state and power source, which will allow sweep personnel to ascertain the condition of an area even in the event of loss of power; and
- battery-backed-up "Secure" state to eliminate the need to re-sweep an area in the event of a power failure and yet to monitor the loop sensors to ensure that the zone remains "Secure." (This final design feature saves countless man hours of accelerator operators' time to re-sweep areas after minor power glitches.)

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